ME6404 – Fall 2009
Lab 1

Laboratory Tasks

Develop a basic understand of the laboratory equipment.
Change the speed of the portable bridge crane.
Record the time response of the system and measure the effect on the pendulum swing.

Drive Parameterization

Move the trolley a set distance using 3 different speeds. Speed is specified in terms of percent, with 100% being 0.243 m/s. The drive uses a trapezoidal velocity profile with an acceleration of approximately 1.01 m/s^2, as seen in Figure 1. Use speeds of: 30%, 60%, and 100%.

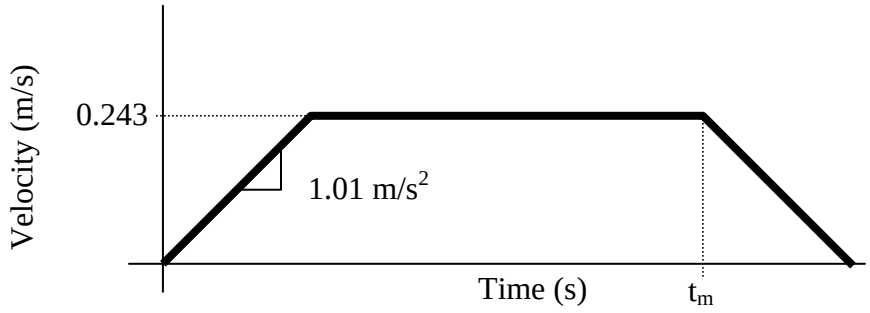

Figure 1: Drive System Velocity Profile.

For each trial, move the crane 30 cm. Given each trial uses a different velocity, the move time in each case will be different.

- Your first task is to calculate the move time, t_m, for each of the three speeds. Figure 1 shows the move time, t_m, in relation to the velocity profile. Keep in mind that the ramp acceleration is constant for all three cases.

Crane Operation

- Open "**Bridge Crane**" on the desktop. Click the "Call Buzz for help" button to get an explanation of the GUI. See Figure 2.
- Click the **Calibrate** button to calibrate the crane's graphical user interface (GUI).
- To operate the crane, you can use the control pendent or the GUI. To begin moving the crane, press the **Start** button. The crane has two axes, the bridge and the trolley. The trolley moves left and right and the bridge moves forward and reverse (these directions are relative to the crane itself and not relative to the user).
- Make sure the payload is suspended approximately **18** inches below the trolley. Also set this length appropriately in **(E)**. Press enter after entering the number for the length in cm. Then click **"set length"**.

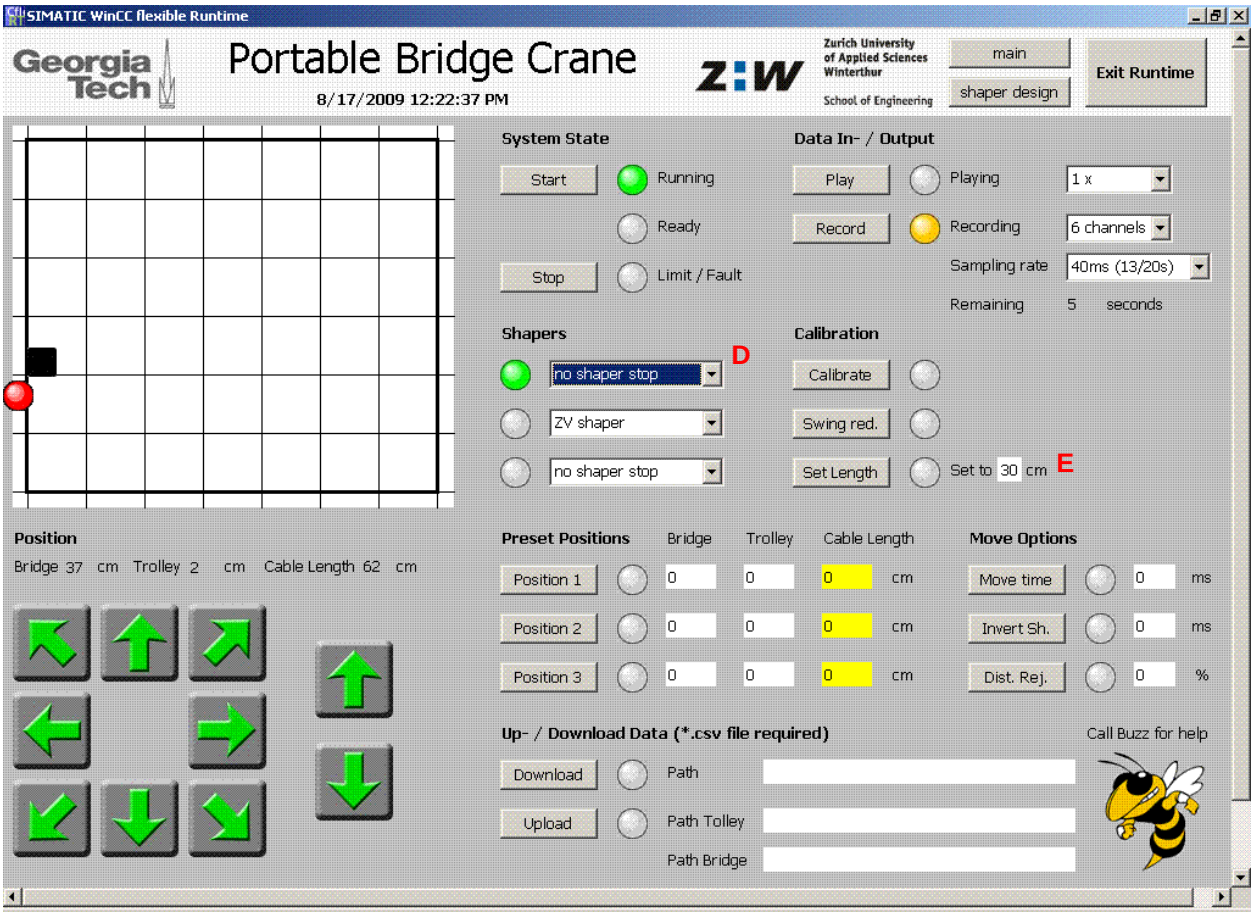

Figure 2: Bridge Crane GUI

- For this lab, only use the trolley axis (the horizontal axis on the GUI). There are three drop down menus available for you to choose your desired input shaper. Choose a drop down menu and select "**No shaper**" then click on the **circular button** next to it. Manually position the crane such that the payload will not run into any obstacles during the tests. Also make sure that the trolley is on the '**LEFT**' end of the workspace (relative to the crane), so that during the test, the trolley has enough room to move 30 cm. If the trolley runs into the end, the crane will automatically stop moving.
- Choose the "**no shaper stop**" **(D)** in figure 2 from one the drop down menus. Now you will need to click the button labeled "Shaper design" on the top right to edit the characteristics for this haper.
- Referring to Figure 3, in the drop down menu **(A)**, choose **"no shaper stop"**. Click show **(A1)**. **(B)** are the amplitudes of the impulses and correspond to the maximum speeds in percentage. The second value should always be equal to the negative of the first in order to bring the trolley to a stop. **(C)** are the impulse times at which the above impulses should be executed. The first number should always be zero, and the second number will be the move time, t_m, in milliseconds.

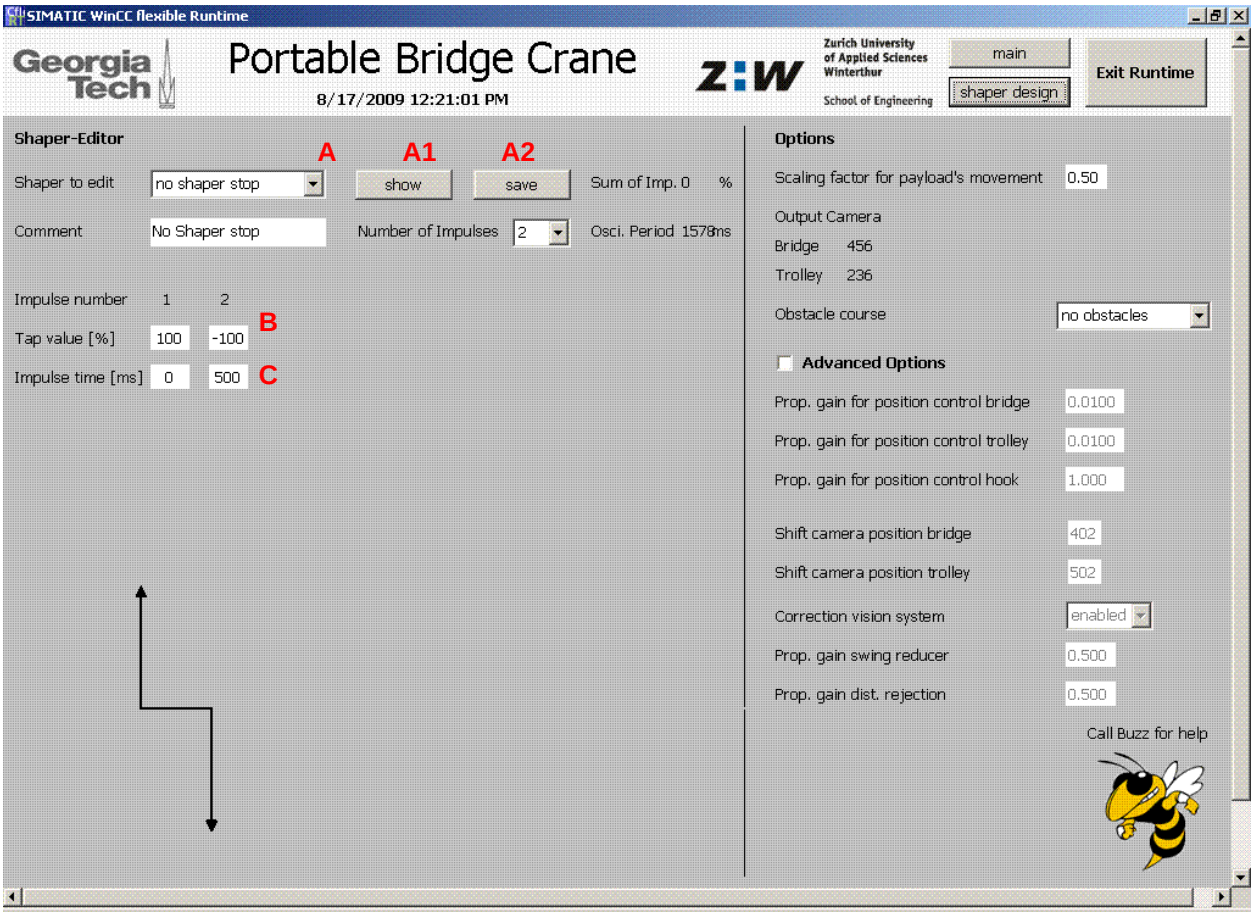

Figure 3: Shaper design

- Once you are happy with your shaper, click on **(A2)** to save. Go back to the first screen on the GUI (Figure 2) and make sure **(D)** drop down menu says "**no shaper stop".**
- To record your response, hit the **record** button. The PLC will only record about 14 seconds of data (6 channel, 40ms sampling rate), so when you press record be ready to move the crane. Each time the **record** button is pressed, the PLC starts recording over again, and all previous data is lost.
- Hit **record** and press and HOLD the **right** button to move the trolley.
- Once the trolley has moved and four or five periods of the crane pendulum have elapsed, release the button. The trolley will return to its original position.
- Once the record light has gone off, stop the crane by pressing the **Stop** button
- Download the data from the PLC to the computer by pressing the **Download** button. Note the path and filename that the computer is downloading to, it should be 'D:\ME6404\download.csv'. The computer can only download data if the crane is stopped.
- To run another experiment stop the payload from swinging. This can be done two ways:
    1. Manually stopping the payload by hand.
    2. Using the Swing Reducer button on the crane interface. The swing reducer attempts to zero out the vibration of the crane. Once the payload is virtually still, unclick the Swing Reducer button and continue with the experiment.

Analyzing Data

- Open Matlab and change the current directory to d:\ME6404. Make sure the blue Ethernet cable labeled is connected to the laptop. The laptop needs the internet for Matlab license check.
- Type "newerplcdata('download.csv')" and press enter. The program will prompt you for a file name, enter one (i.e. test1) and press enter.
- Plots of the recorded data appear.
- The filename you specified will be created in the current directory. To access this data, use the matlab command "load filename". An array with the following form is loaded:

$$\begin{bmatrix} \text{time (s)} \\ \text{desired trolley velocity (rpm)} \\ \text{actual trolley velocity (rpm)} \\ \text{payload swing (trolley axis) (rad)} \\ \text{desired bridge velocity (rpm)} \\ \text{actual bridge velocity (rpm)} \\ \text{payload swing (bridge axis) (rad)} \end{bmatrix}$$

- Note that for the velocity data, 120rpm = 100% = .243 m/s
- When recording data, the camera needs to be active – this is indicated by the flashing LED lights. If it is not flashing for whatever reason, cycle power by disconnecting and reconnecting the black cable on the camera.

Final Notes

- Transfer your data and plots to some personal media storage device.
- Use distinct names for each file.
- Data from the "ME6404" folder will be erased on a weekly basis.
- Leave the laptop running so that remote researchers can operate the crane

Lab Write-Up

Discuss your work in less than 1 page of text. However, include as many plots as you feel necessary to illustrate your conclusions.

The text must cover:

- what you did
- what were the results

Following the text should be a set of plots. The plots must include:

- the encoder time history for each of the 3 tests
- the pendulum vibration for each of the 3 tests

The Report is Due at the Beginning of Lab Next Week